The Application of the New Scaling Relations and Global Isomorphism to the Study of Liquid-Vapor Equilibrium

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The similarity laws allow one to set a correspondence between different thermodynamic values without explicit use of the equation of state. The search for the similarity and the unifying principles in the description of the variety of the thermodynamic properties of complex matter is the key point of statistical physics. Among different similarity laws the regularity concerning the Zeno line (ZL) has been widely studied recently as far as it appears to be valid for a wider class of real substances and model systems than others [1,2]. This regularity characterizes the states where the compressibility factor is unity. Corresponding curve on the density - temperature plane is appeared to be a straight line. On the other hand the connection between continuous and discrete systems in Statistical Physics is the source of new methods and fruitful applications. The lattice models (LM) are usually considered as the simplified representation of the real ones. Due to their numerical and analytical tractability they serve as the main sources of the rigorous results. Famous Onsager's solution of the two-dimensional Ising model is the well-known example which gave a new impact to the critical phenomena theory (CPT). In the modern CPT the ideology of the isomorphic classes of the critical behavior provides the description of the real systems using the results obtained for the model systems among which the lattice models play important role. In [3, 4] the approach was proposed which extends the notion of the isomorphism between the LM and the real fluid from the critical region to the whole liquid-vapor part of the phase diagram. Corresponding projective transformation between the lattice variables (density ρ and temperature t) and real liquid variables (density n and temperature T) have been also offered in [3,4]. This transformation maps the critical point ($\rho = ½$; $t = 1$) and vertical ZL ($\rho = 1$) on the the (ρ, t) plane for the LM onto the point (n_c,T_c) and ZL on the (n, T) plane. Using this transformation we calculated the binodals, isobaric thermal expansion coefficients and saturation pressure for a number of model systems and real substances and show that suggested method provides an acceptable accuracy in a wide liquid-gas temperature domain.

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